Chapter 1

Introduction

Organization

This almanac contains information about current and historical emissions and air quality in California. It provides a reference for anyone interested in air quality. When using this information, please remember that the emission and air quality values represent a snapshot of the data at a particular point in time. This edition of the almanac is a May 1998 snapshot of the 1995 emission inventory and the 1997 air quality databases. Historical emission and air quality data can change over time. For example, emission data may be revised to reflect changes or refinements in estimation methods, and air quality data may be changed because of corrections or additions made since the time the report was printed.

The Air Resources Board's (ARB) most current emission and air quality data are available on the World Wide Web. On the web, the data can be viewed directly from the ARB's emission inventory and air quality databases. The emission inventory data can be found at *www.arb.ca.gov/emisinv/emsmain/emsmain.htm*. The emission database contains data for more than 11,000 individual facilities, such as power plants and refineries. It also includes approximately 250 area source categories, such as consumer products and architectural coatings, and it provides data for on-road and off-road vehicles, including cars, trucks, trains, ships, aircraft, and farm equipment. In addition, data for natural emissions, except biogenics, are available.

Historical air quality data can be accessed on the web at *www.arb.ca.gov/aqd/aqd.htm*. From this point, several options are available. The most recent air quality data can be accessed directly from the ARB's air quality database using the "Interactive Data" option. Using this option, the user may select the desired information, knowing that it reflects what is currently in the database. Summaries of annual air quality data are available for ozone, particulate matter (PM_{10}), and toxics under the "Annual Summaries" option. These data are a summarized snapshot of the reviewed data that were in the ARB air quality database at the time the page was last updated. Finally, the "Year-to-Date Ozone Report" option is a compilation of preliminary current year ozone data from selected monitoring sites in the State's five most populated air basins. This report is updated monthly during the April through October ozone season.

In addition to the air quality data on the World Wide Web, two compact disks (CDs) containing air quality data are available from the Air Resources Board. Each CD contains multiple years of California air quality data (1980-1996 criteria pollutant data and 1990-1996 toxics data). The data on the first CD are easily displayed on a map or as a time series graph using the Voyager data visualization software, which is also included on the CD. The second CD contains the same basic data, stored in ASCII files and other forms that can be used by analysts to process their own data. The CDs are available free upon request from the ARB's Planning and Technical Support Division by calling (916) 323-8482.

The emission and air quality information provided in the remainder of this document are based on data maintained in the ARB's emission and air quality databases. The document is divided into five main chapters as described below. The chapters include descriptive information, graphics, and tabular data.

Chapter 1 contains introductory material that describes the information necessary to understand the remaining chapters. It includes information about emission estimating, air quality monitoring, State and national ambient air quality standards, and area designations for the State and national standards.

Chapter 2 contains information about current emissions and air quality at the statewide level, including lists of the State's highest emitting facilities. It is organized by pollutant for the three pollutants that still pose major air quality problems: ozone, particulate matter (specifically, PM_{10}), and carbon monoxide (CO). The chapter also contains information about how California air quality compares to that of other parts of the United States.

Chapters 3 and 4 include information about historical emission and air quality trends. Chapter 3 provides statewide information for ozone, PM_{10}, CO, lead, nitrogen dioxide (NO_2), and sulfur dioxide (SO_2). Chapter 4 gives information for the State's five most populated air basins: the South Coast, San Francisco Bay Area, San Joaquin Valley, San Diego, and Sacramento Valley Air Basins. This chapter focuses on ozone, PM_{10}, and CO. Chapter 4 also includes information on NO_2 for the South Coast and San Diego Air Basins since these two areas had NO_2 problems in the past.

Finally, Chapter 5 includes emission data from 1985 through 1995 and air quality data from 1980 through 1997 for all counties and for all of California's 15 air basins. Five pollutants are included: ozone, PM_{10}, CO, NO_2, and SO_2. The data are provided in tabular format and are organized alphabetically by air basin (Note: similar air quality information is also provided in the Appendix, arranged by pollutant). In addition to the summary data, Chapter 5 also includes lists of the highest emitting facilities in each air basin.

Interpreting the Air Quality Statistics: A number of air quality indicators are used in this document, representing both measured values and statistically derived values. In general, the 1-hour, 8-hour, and 24-hour average concentrations, the annual averages, and the number of days above the State and national standards are measured values. In contrast, the peak indicator values were statistically derived from the measured data. The peak indicator represents the maximum concentration expected to occur once per year. This indicator is based on a statistical calculation using the ambient data collected at each monitoring site in the area. It is a calculated value, not an actual measured concentration. However, because it is based on a robust statistical calculation, it is more stable, thereby providing a trend indicator that is not highly influenced by year-to-year changes in meteorology.

In general, the air quality trends in this almanac represent data that have been summarized from a network of monitoring sites to characterize the air quality in a particular region (for example, a county or air basin). Whenever data are summarized, the resulting statistics may be influenced by a number of factors, including the number of monitoring sites in operation and the completeness of the data. To help in interpreting the air quality trends, the ARB has included information on site openings, site closures, and data completeness on the World Wide Web. The information can be found at *www.arb.ca.gov/aqd/almanac/almanac99.htm*. The information is also available from the ARB's Planning and Technical Support Division by calling (916) 323-8482.

Interpreting the Emission and Air Quality Trends: A number of trends are presented in this almanac. Emission and air quality trends for the same pollutant are usually highly correlated. In some cases, however, the two trends may differ, at least in terms of the rate of increase or decrease. The comparison of emission trends to air quality trends is complex, and a number of confounding factors can affect the resulting trends, such as the impacts of transported ozone and PM_{10} from one area to another. An area can show a stable (or flat) emission trend because local emission growth offsets the reductions achieved through technology, but this area may show an improvement in air quality because ambient concentrations reflect the impact of transport from a region that has improved. Other factors that can affect air quality are meteorology and changes in monitoring sites (both site closures and the establishment of new sites). In addition, the emission trends and some air quality trends are based on estimates. These estimates use the best available methods, however, they embody some degree of uncertainty. All of these factors should be kept in mind when using and interpreting the trends.

The air quality trends in this almanac are for the period 1980 to 1997 for all pollutants except PM_{10} which is shown from 1988 to 1997. The emission estimates are presented for the years 1985, 1990, and 1995, the period for which we have the greatest confidence in the estimates. Generally, air quality trends are based on data which have been consistently measured over the period presented. Air quality data are more reliable than emission estimates, which have a greater potential for inaccuracies. As a result, care should be taken in the use of these data either absolutely or in trend analyses.

California Facts and Figures

California is truly a "Land of Contrasts." The State offers a variety of physical features, including mountains, valleys, oceans, and deserts. In terms of size, California ranks third in the United States, after Alaska and Texas. California covers a total area of about 164,000 square miles and is larger than many nations in the world today, including Great Britain, Japan, Italy, and Norway. Of California's total area, about 156,000 square miles are land and almost 8,000 square miles are water. The Pacific Ocean is the western boundary of California, forming a coastline more than 1,200 miles long. This is nearly equal to the combined Atlantic coastlines of Maine, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, and New Jersey.

California is blessed with a wide range of scenery and climates. The southern coastal areas enjoy a Mediterranean climate with the oak-studded hills and sunny beaches for which the State is famous. The northern coast is covered by fog-shrouded redwood forests. Inland lies the vast Central Valley with its millions of acres of cropland. The Sierra Nevada in the eastern half of California runs nearly two-thirds the length of the State. The Sierra includes the highest mountain in the continental United States, Mount Whitney, as well as the southernmost glacier in North America. Most of the southeastern portion of the State is desert, with sun-baked Death Valley, the lowest point in North America, lying only 60 miles from Mount Whitney. Further south are the scenic mountain ranges of the Mojave Desert. To a large degree, California's pleasant climate and abundance of relatively level land are the major features that have drawn people to the State, and with these people have come the challenges of controlling emissions to improve air quality.

Sources of Emissions in California

California is a diverse State with many sources of air pollution. To estimate the sources and quantities of pollution, the Air Resources Board, in cooperation with local air pollution control districts and industry, maintains an emission inventory of California emission sources. Sources are subdivided into four major emission categories: stationary sources, area-wide sources, mobile sources, and natural sources. The tables in Chapter 2, sections B and C provide some examples of the types of emission sources that are included in each of these categories.

Stationary source emissions are based on estimates made by facility operators and local air pollution control districts. Emissions from specific facilities can be identified by name and location. Area-wide emissions are estimated by ARB and district staffs. Emissions from area-wide sources may be either from small individual sources, such as residential fireplaces, or from widely distributed sources that cannot be tied to a single location, such as dust from unpaved roads. Mobile source emissions are estimated by ARB staff with assistance from districts and other government agencies. Mobile sources include on-road cars, trucks, and buses and other sources such as boats, off-road recreational vehicles, aircraft, and trains. Natural sources are also estimated by the ARB staff and the air districts. These sources include geogenic hydrocarbons, natural wind-blown dust, and wildfires. Biogenic hydrocarbon emission estimates are not included in this document.

For the inventoried emission sources, the ARB compiles emission estimates for total organic gases (TOG), reactive organic gases (ROG), carbon monoxide (CO), oxides of nitrogen (NO_x), oxides of sulfur (SO_x), particulate matter (PM), and particulate matter with an aerodynamic diameter of 10 microns or smaller (PM_{10}). This almanac focuses on emission and air quality information for the most significant pollutants in California: the ozone precursors NO_x and ROG, PM_{10}, and CO. These pollutants are the most significant because many areas of the State do not attain the State or national ambient air quality standards for these pollutants.

Air Quality Monitoring

Meteorology acts on the emissions released into the atmosphere to produce pollutant concentrations. These airborne pollutant concentrations are measured throughout California at air quality monitoring sites. The Air Resources Board operates a statewide network of monitors. Data from this network are supplemented with data collected by air districts, other public agencies, and private contractors. In total, there are more than 250 air quality monitoring sites in California. In addition, a few monitoring sites are located in Baja California, Mexico. These sites were established in cooperation with the United States Environmental Protection Agency (U.S. EPA) and the Mexican government to monitor the cross-border transport of pollutants and precursors. Each year, more than ten million air quality measurements from all of these sites are collected and stored in a comprehensive air quality database maintained by the ARB. To ensure the integrity of the data, the ARB routinely conducts audits and reviews of the monitoring instruments and the resulting data.

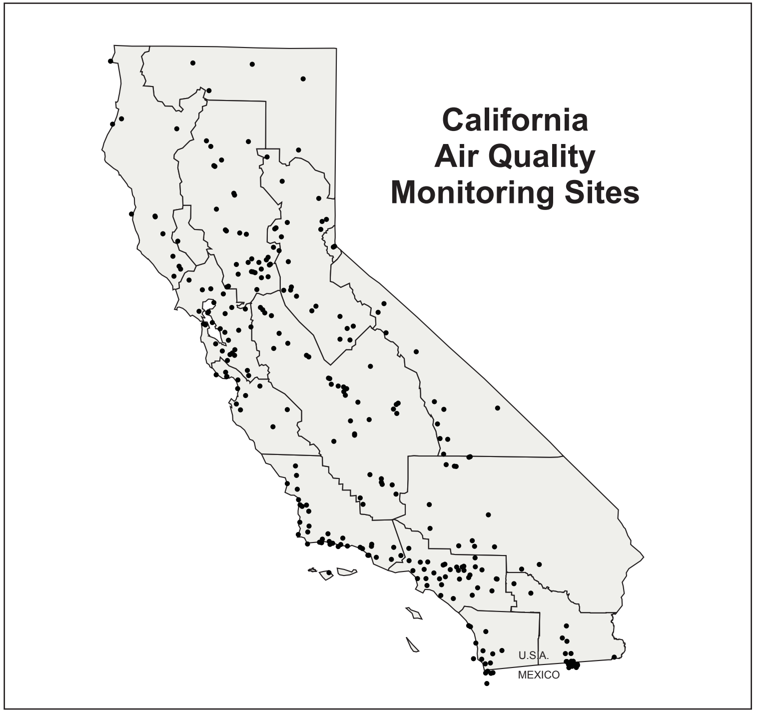

Figure 1-1

California Air Basins

California contains a wide variety of climates, physical features, and emission sources. This variety makes the task of improving air quality complex because what works in one area may not work in another area. To better manage common air quality problems, California is divided into 15 air basins, as shown in Figure 1-2 and Table 1-1. The Air Resources Board established the initial air basin boundaries during 1968.

An air basin generally has similar meteorological and geographic conditions throughout. To the extent possible, the basin boundaries follow along political boundary lines and are defined to include both the source area and the receptor area. However, air often moves freely from basin to basin. As a result, ozone and PM_{10} can be transported across air basin boundaries, and interbasin transport is a reality that must be dealt with in air quality programs. Over time, the air basin boundaries have been changed several times, to provide for better air quality management.

Figure 1-2

List of Counties in Each Air Basin

Great Basin Valleys Air Basin
- Alpine County
- Inyo County
- Mono County

Lake County Air Basin
- Lake County

Lake Tahoe Air Basin
- El Dorado County (portion)
- Placer County (portion)

Mojave Desert Air Basin
- Kern County (portion)
- Los Angeles County (portion)
- Riverside County (portion)
- San Bernardino County (portion)

Table 1-1

Mountain Counties Air Basin
- Amador County
- Calaveras County
- El Dorado County (portion)
- Mariposa County
- Nevada County
- Placer County (portion)
- Plumas County
- Sierra County
- Tuolumne County

List of Counties in Each Air Basin

North Central Coast Air Basin
- Monterey County
- San Benito County
- Santa Cruz County

North Coast Air Basin
- Del Norte County
- Humboldt County
- Mendocino County
- Sonoma County (portion)
- Trinity County

Northeast Plateau Air Basin
- Lassen County
- Modoc County
- Siskiyou County

Sacramento Valley Air Basin
- Butte County
- Colusa County
- Glenn County
- Placer County (portion)
- Sacramento County
- Shasta County
- Solano County (portion)
- Sutter County
- Tehama County
- Yolo County
- Yuba County

Table 1-1 (continued)

List of Counties in Each Air Basin

Salton Sea Air Basin
- Imperial County
- Riverside County (portion)

San Diego Air Basin
- San Diego County

San Francisco Bay Area Air Basin
- Alameda County
- Contra Costa County
- Marin County
- Napa County
- San Francisco County
- San Mateo County
- Santa Clara County
- Solano County (portion)
- Sonoma County (portion)

Table 1-1 (continued)

San Joaquin Valley Air Basin
- Fresno County
- Kern County (portion)
- Kings County
- Madera County
- Merced County
- San Joaquin County
- Stanislaus County
- Tulare County

South Central Coast Air Basin
- San Luis Obispo County
- Santa Barbara County
- Ventura County

List of Counties in Each Air Basin

South Coast Air Basin

- Los Angeles County (portion)
- Orange County
- Riverside County (portion)
- San Bernardino County (portion)

Table 1-1 (continued)

California and National Ambient Air Quality Standards

Very simply, an ambient air quality standard is the definition of "clean air." More specifically, a standard establishes the concentration at which the pollutant is known to cause adverse health effects to sensitive groups within the population, such as children and the elderly. Both the California and federal governments have adopted health-based standards for the criteria pollutants, which include ozone, particulate matter (PM_{10} and $PM_{2.5}$), and carbon monoxide. For some pollutants, the California (State) and national standards are very similar. For other pollutants, the State standards are more stringent. The differences in the standards are generally explained by the different health effects studies considered during the standard-setting process and the interpretation of the studies. In addition, the State standards incorporate a margin of safety to protect sensitive individuals (a complete list of the State and national ambient air quality standards can be found on the World Wide Web at *www.arb.ca.gov/aqs/aqs.htm*). In general, the air quality standards are expressed as a measure of the amount of pollutant per unit of air. For example, the particulate matter standards are expressed as micrograms of particulate matter per cubic meter of air ($\mu g/m^3$).

Ozone

Ozone is a colorless gas with a pungent odor. It is the chief component of urban smog. Ozone is not directly emitted as a pollutant, but is formed in the atmosphere when hydrocarbon and NO_x precursor emissions react in the presence of sunlight. Meteorology and terrain play major roles in ozone formation. Generally, low wind speeds or stagnant air coupled with warm temperatures and cloudless skies provide for the optimum conditions. As a result, summer is generally the peak ozone season. Because of the reaction time involved, peak ozone concentrations often occur far downwind of the precursor emissions. Therefore, ozone is a regional pollutant that often impacts a widespread area.

Ozone impacts lung function by irritating and damaging the respiratory system. In addition, ozone causes damage to vegetation, buildings, rubber, and some plastics. Recognizing the health impacts of day-long exposure, the United States Environmental Protection Agency promulgated an 8-hour ozone standard in 1997 as a successor to the 1-hour standard which was established in 1979. However, the transition to the 8-hour standard is just beginning, and the 1-hour standard is the primary focus of this almanac.

State Ozone Standard:
0.09 ppm for 1 hour,
not to be exceeded.

National Ozone Standards:
0.12 ppm for 1 hour,
not to be exceeded more
than once per year *and*
0.08 ppm for 8 hours,
not to be exceeded,
based on the fourth highest
concentration averaged
over three years.

Table 1-2

Particulate Matter (PM_{10} and $PM_{2.5}$)

PM_{10} refers to particles with an aerodynamic diameter of 10 microns or smaller. For comparison, the diameter of a human hair is about 50 to 100 microns. PM_{10} is a mixture of substances that includes elements such as carbon, lead, and nickel; compounds such as nitrates, organic compounds, and sulfates; and complex mixtures such as diesel exhaust and soil. These substances occur in the form of solid particles or as liquid droplets. Some particles are emitted directly into the atmosphere. Other particles, referred to as secondary particles, result from gases that are transformed into particles through physical and chemical processes in the atmosphere.

PM_{10} includes a subgroup of finer particles called $PM_{2.5}$. The fine particles pose an increased health risk because they can deposit deep in the lung and contain substances that are particularly harmful to human health. The United States Environmental Protection Agency promulgated national $PM_{2.5}$ standards in 1997. However, the transition to the $PM_{2.5}$ standards is just beginning and, therefore, the PM_{10} standards are the primary focus of this almanac.

State PM_{10} Standards:
50 µg/m^3 for 24 hours *and*
30 µg/m^3 annual geometric mean,
neither to be exceeded.

National PM_{10} Standards:
150 µg/m^3 for 24 hours,
not to be exceeded, based on
the 99th percentile concentration
averaged over 3 years *and*
50 µg/m^3 annual arithmetic mean
averaged over 3 years.

National $PM_{2.5}$ Standards:
65 µg/m^3 for 24 hours,
not to be exceeded, based on
the 98th percentile concentration
averaged over three years *and*
15 µg/m^3 annual arithmetic mean
averaged over 3 years.

Table 1-3

Carbon Monoxide

Carbon monoxide is a colorless and odorless gas that is directly emitted as a product of combustion. The highest concentrations are generally associated with cold stagnant weather conditions that occur during winter. In contrast to ozone, which tends to be a regional pollutant, CO problems tend to be localized.

Carbon monoxide is highly toxic because it is readily absorbed through the lungs into the blood, where it binds with hemoglobin and reduces the ability of the blood to carry oxygen. As a result, insufficient oxygen reaches the heart, brain, and other tissues. The harm caused by CO can be critical for people with heart disease (angina), chronic lung disease, or anemia, as well as for unborn children. Even healthy people exposed to high levels of CO can experience headaches, fatigue, slow reflexes, and dizziness. Health damage caused by CO is of greater concern at high elevations where the air is less dense, aggravating the consequences of reduced oxygen supply. As a result, California's CO standard is more stringent for the Lake Tahoe Air Basin.

State CO Standards:
20 ppm for 1 hour *and*
9.0 ppm for 8 hours,
neither to be exceeded.

6 ppm for 8 hours
(Lake Tahoe Air Basin only),
not to be equaled or exceeded.

National CO Standards:
35 ppm for 1 hour *and*
9 ppm for 8 hours,
neither to be exceeded more
than once per year.

Table 1-4

California and National Area Designations

Both the California and federal governments use monitoring data to designate areas according to their attainment status for most of the pollutants with ambient air quality standards. The purpose of the designations is to identify those areas with air quality problems and thereby initiate planning efforts to make the air more healthful. There are three basic designation categories: nonattainment, attainment, and unclassified. In addition, the California (State) designations include a subcategory of the nonattainment designation, called nonattainment-transitional. This transitional designation is given to nonattainment areas that are making progress and nearing attainment.

A nonattainment designation indicates that the air quality violates an air quality standard. Although a number of areas may be designated as nonattainment for a particular pollutant, the severity of the problem can vary greatly. For example, in two ozone nonattainment areas, the first area has a measured maximum concentration of 0.13 parts per million (ppm), while the second area has a measured maximum concentration of 0.23 ppm. It is obvious that the second area has a more severe problem, and will need a more stringent emissions control strategy. To identify the severity of the problem and the extent of planning required, nonattainment areas are assigned a classification that is commensurate with the severity of the air quality problem (e.g., severe, serious, moderate). In contrast to nonattainment, an attainment designation indicates that the air quality does not violate the established standard. In most cases, areas designated as attainment must develop and implement maintenance plans designed to assure continued compliance with the standard. Finally, an unclassified designation indicates that there is insufficient data for determining attainment or nonattainment (more detailed information on the area designation categories can be found on the web at *www.arb.ca.gov/desig/desig.htm*).

Ozone

Several areas in the northern and central portions of California are designated as attainment for the State ozone standard. However, most of the rest of the State, including all of the major urban areas, have ozone concentrations that violate the State standard, and therefore, are designated as nonattainment. During 1997 and 1998, several nonattainment areas were redesignated as nonattainment-transitional. The air quality improvement in these areas is partly attributable to the implementation of Cleaner Burning Gasoline. Although few areas have made sufficient progress to be redesignated as attainment for the State ozone standard, ozone precursor emissions continue to decline throughout California. As a result, more areas should eventually qualify for attainment status.

Figure 1-3

Similar to the State designations, most of the major urban areas in California are designated as nonattainment for the national 1-hour ozone standard. Two areas, Amador County and Calaveras County, are designated as unclassified/attainment. Ozone concentrations in the remaining areas do not violate the national 1-hour standard. As a result, in June 1998, the United States Environmental Protection Agency categorized these regions as areas where the 1-hour national standard no longer applies. Although the ambient ozone concentrations in these areas no longer violate the 1-hour standard, they may violate the new national 8-hour standard. Therefore, as the U.S. EPA transitions to the 8-hour ozone standard, the agency will redesignate these areas as appropriate.

Figure 1-4

PM_{10}

The majority of California is designated as nonattainment for the State PM_{10} standards. Three counties in the northern half of the State remain unclassified, and only one area, Lake County Air Basin, is designated as attainment.

PM_{10} remains a widespread problem, and its causes are very diverse. Because of the variety of sources and the size and chemical make-up of the particles, the PM_{10} problem can vary considerably from one area to the next. In addition, high PM_{10} concentrations are seasonal, and the season varies from area to area. For example, in some areas, windblown dust may contribute to high PM_{10} concentrations in the summer and fall, while in other areas, high concentrations due to secondary particles may occur in the winter. As a result, two areas with similar PM_{10} concentrations may have very different PM_{10} problems, and no single statewide control strategy will be effective in dealing with these problems.

Figure 1-5

In contrast to the State PM_{10} designations, there are only two designation categories for the national PM_{10} standards: nonattainment and unclassified. Areas designated as nonattainment for the national PM_{10} standards are required to develop and implement plans designed to meet the standards. Although the U.S. EPA has not provided for an attainment designation, several areas in the State have PM_{10} air quality that does not violate the national standards.

Recognizing the health impacts of fine particles (those less than 2.5 microns in diameter), the United States Environmental Protection Agency recently promulgated a $PM_{2.5}$ standard. While the area designations and planning requirements have not yet been established for $PM_{2.5}$, the actions taken to reduce PM_{10} should also help in reducing $PM_{2.5}$.

Figure 1-6

Carbon Monoxide

Currently, there are only two nonattainment areas for the State CO standards: Los Angeles County and the city of Calexico, in Imperial County. California has made tremendous progress in reducing CO concentrations in the last ten years, during which 13 areas with over 12.5 million people have been redesignated as attainment. Much of the progress in reducing ambient CO is attributable to motor vehicle controls and the introduction of cleaner fuels.

The outlook for further reducing CO concentrations in Los Angeles County is good, and continued emission reductions should assure attainment sometime in the future. The problem in Calexico is unique in that the area is probably impacted by emissions from Mexico. Additional studies are needed to determine the most effective control strategy for this area.

Figure 1-7

The U.S. EPA uses only two designation categories for CO: unclassified/attainment and nonattainment. All areas of California except the South Coast Air Basin are currently designated as unclassified/attainment for the national CO standards. Furthermore, the CO problem in the South Coast area is limited to only a small portion of Los Angeles County. Most CO is emitted by cars and trucks, and the Air Resources Board's motor vehicle controls should be sufficient to overcome the problem in the coming years. In addition to Los Angeles County, the city of Calexico, in Imperial County, also has carbon monoxide concentrations that violate the national standards. However, the U.S. EPA has not acted to change this area's designation from unclassified/attainment to nonattainment.

Figure 1-8

(This page intentionally left blank.)